

# ANNUAL TECHNICAL REPORT

## Seismic Network Operations Along the Wasatch Front Urban Corridor and Adjacent Intermountain Seismic Belt

January - December 1998  
YEAR ONE

U.S. Geological Survey Cooperative Agreement No. 1434-HQ-98-AG-01939

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Program Element: Seismic Networks  
Key Words: Regional Seismic Hazards, Real-time Earthquake Information,  
Seismotectonics, Engineering Seismology

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March 29, 1999

**Seismic Network Operations Along the Wasatch Front  
Urban Corridor and Adjacent Intermountain Seismic Belt**  
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Seismotectonics, Engineering Seismology

**Non-technical Summary**  
**January 1 - December 31, 1998**

Under this cooperative agreement, the University of Utah receives partial support to maintain and operate a 100-station regional seismic network—as well as a regional earthquake information center—with emphasis on the seismically hazardous Wasatch Front urban corridor of north-central Utah. During the report period, of 6840 seismic events analyzed, a total of 1179 earthquakes were located in the Utah study region, including 48 shocks of magnitude 3.0 and larger. Other notable efforts related to the addition of several state-of-the-art seismograph stations to our network, which improve our capability for rapid earthquake alert as well as our ability to provide data/information to the public and to national archives.

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**Summary**

**January - December 1998**

This cooperative agreement partially supports the operation of the University of Utah's 100-station telemetered regional seismic network. USGS support focuses on the seismically hazardous Wasatch Front urban corridor of north-central Utah but also encompasses neighboring areas of the Intermountain Seismic Belt. Primary products of this USGS support are quarterly bulletins, periodic earthquake catalogs, and the services of a regional earthquake-recording and information center.

This report covers the time period from January 1 through December 31, 1998. During the report period, we detected and analyzed approximately 6840 seismic events, including local earthquakes, teleseismic and regional earthquakes, and blasts. A total of 3066 earthquakes were located in the Intermountain Seismic Belt—including 1179 within the Utah region, of which 808 were within the Wasatch Front region. Forty-eight earthquakes of magnitude ( $M_C$ ) 3.0 and larger occurred in the Utah region during the report period. The largest seismic event was one of  $M_C$  4.9 that occurred on January 2, 1998, approximately 12 km ESE of Beaver, Utah.

In addition to fulfilling responsibilities for routine network operations and earthquake data processing, accomplishments (and related efforts) during the report period included the following:

- field installation of two additional REF TEK digitally-telemetered, three-component broadband seismograph stations in Utah's Wasatch Front area (plus a third new station installed in east-central Utah with other funds), resulting in a total of 11 broadband stations within or immediately bordering the Utah region—5 Univ. of Utah plus 6 USNSN;
- continued software development to integrate new digital data streams (REF TEK and USNSN) with existing analog data streams for routine analysis;
- extensive ongoing attempts to persuade state and Olympic officials to help build a real-time seismic information system in Utah prior to the 2002 Winter Olympic Games in Salt Lake City;

- planning and arrangements for testing the *Antelope* real-time data acquisition and information system cooperatively developed by Kinemetrics and Boulder Real-time Technologies;
- steps towards submitting 18 years of Univ. of Utah short-period waveform data to the IRIS Data Management Center in SEED format, including (1) use of IRIS's PDCC (Portable Data Collection Center) software, (2) compilation of a database inventory of instrument components for all stations in our network since digital recording began in 1981, and (3) compilation of system response information for all past and present stations in our network;
- work on software development to automatically convert Utah broadband data to SEED format for submission to the IRIS Data Management Center;
- automated submission of earthquake catalog data for the Utah region several times per day to the CNSS composite catalog;
- completion of a detailed analysis of Rex Allen's picker algorithm, as implemented within Earthworm, and preliminary "tuning" of Earthworm's picker to perform reliably on Utah waveform data (see Pechmann, 1998);
- systematic determination of local magnitudes ( $M_L$ ) and  $M_L$  station corrections using local USNSN and Utah broadband stations, for all coda magnitude ( $M_C$ ) 2.5 and greater earthquakes located in the Utah region since January 1, 1994 (project involved the analysis of more than 1500 earthquakes in the Intermountain seismic belt including 271 events of a major aftershock sequence, and will be completed before early 1999);
- steps toward a substantial upgrade of our Web pages (URL: [www.seis.utah.edu](http://www.seis.utah.edu)), which will include (1) complete reorganization of pages to make them more user friendly, (2) implementing USGS seismicity map presentation format, and (3) making seismic data available to GIS users in Arc/Info native format;
- completion of a network inventory for the CNSS (see <http://www.cnss.org/NETS>) and major progress towards a comprehensive station inventory for the IASPEI handbook;
- assessment of network-related computer systems and equipment for Year 2000 vulnerability; and
- continued systematic upgrade of aging field hardware and electronics in our analog short-period network, including station calibrations and determinations of GPS-quality station locations using Trimble SSI dual-frequency receivers.

**TABLE OF CONTENTS**

<b>NON-TECHNICAL SUMMARY</b>	ii
<b>SUMMARY</b>	iii
<b>INTRODUCTION</b>	
General Background	1
Regional Seismic Network	1
Overview of Seismicity	1
<b>ACCOMPLISHMENTS</b>	
Routine Network Operations	12
Internet Access to Utah Earthquake Information	12
Analog Network and Central Recording Lab Upgrades	12
Rapid Earthquake Alert	12
New Digitally-telemetered Broadband Stations	12
Routine Use of Broadband Data for Local Magnitude Calculations	13
Contributions to the CNSS Composite Catalog and Network Inventory	13
Long-term Archiving of Seismic Waveform Data	13
Year 2000 Vulnerability Analysis	13
<b>AVAILABILITY OF DATA</b>	13
<b>REPORTS AND PUBLICATIONS</b>	14
<b>DISTRIBUTION OF FINAL TECHNICAL REPORT</b>	15

## INTRODUCTION

### General Background

This cooperative agreement supports *network operations* associated with the University of Utah's regional seismograph network of approximately 100 stations. Ongoing USGS support focuses on the seismically hazardous Wasatch Front urban corridor of north-central Utah and also encompasses neighboring areas of the Intermountain Seismic Belt. Primary products for this USGS support are preliminary earthquake catalogs issued on a quarterly basis, periodic finalized earthquake catalogs, and the services of a regional earthquake recording and information center. The seismic network also provides waveform and arrival time data for research.

This cooperative agreement facilitates multiple objectives of the National Earthquake Hazards Reduction Program (NEHRP) for the Wasatch Front area and adjacent Intermountain Seismic Belt through observational seismology. Scientific objectives relate to the characterization of tectonic framework and earthquake potential, surveillance of space-time seismicity and characteristics of small-to-moderate earthquakes (for understanding the nucleation of large earthquakes in the region), and the documentation and evaluation of various earthquake-related parameters for accurate hazard and risk analyses. Scientific results are routinely reported to the USGS under separate research awards.

### Regional Seismic Network

Figure 1 and Table 1 summarize essential information for the current permanently-installed 105-station University of Utah seismic network. Basically, the network consists of 54 stations focused on the Wasatch Front area, an additional 19 stations that provide expanded coverage of the Utah region (chiefly central and southwestern Utah), and another 32 stations covering the continuation of the Intermountain Seismic Belt from south-central Idaho to Yellowstone National Park. Table 1 indicates that, during the period of this award 14 of the 105 stations were maintained by other institutions. The University of Utah handled the field repair and maintenance of 91 stations, 46 of which were sponsored by the USGS under this award. Additionally, a portable-telemetry network of 6 stations is deployed for special studies and/or aftershock surveys.

The development of our telemetered seismic network has consistently focused on quality. Field operations have involved careful site selection and attention to reliable performance. Beyond special attention to station-component quality and reliability, we continue to attend to the in-situ calibration of our entire network—an essential requirement for extracting quantitative information from the waveform analysis of digitally-recorded seismograms.

### Overview of Seismicity

During the period of this award from January 1 through December 31, 1998, we detected and analyzed approximately 6840 seismic events. Of these 45 percent were local earthquakes, 30 percent were teleseisms and regional earthquakes, and 25 percent were blasts. During the 1998 award period, 3066 earthquakes were located in the Intermountain Seismic Belt, including 1179 within the Utah region (Figure 2) and 808 within the Wasatch Front region. In the Utah region, 48 earthquakes of magnitude 3 or larger occurred (Table 2, Figure 3). The number of magnitude 3.0 and larger earthquakes located in the Utah region during the report period was more than three times higher than the average rate of 13 shocks per year. During the project period, 14 earthquakes in the Utah region

were reported as felt (Table 3). The University of Utah Seismograph Stations issued seven press releases after earthquakes in the Utah region that were either felt or larger than a designated threshold magnitude, which was 3.5 during 1998. Approximately 30 percent of the seismicity detected in the Utah region during the report period was associated with areas of ongoing coal-mining-related seismicity, located within a 60 km radius of Price in east-central Utah ( $353 \text{ shocks}, 0.6 \leq M_C \leq 4.0$ ). The largest earthquake to occur in the Utah region during the report period was an  $M_C$  4.9 shock on January 2, 1998, located approximately 12 km ESE of Beaver, Utah.

University of Utah Regional Seismic Network  
December 1998

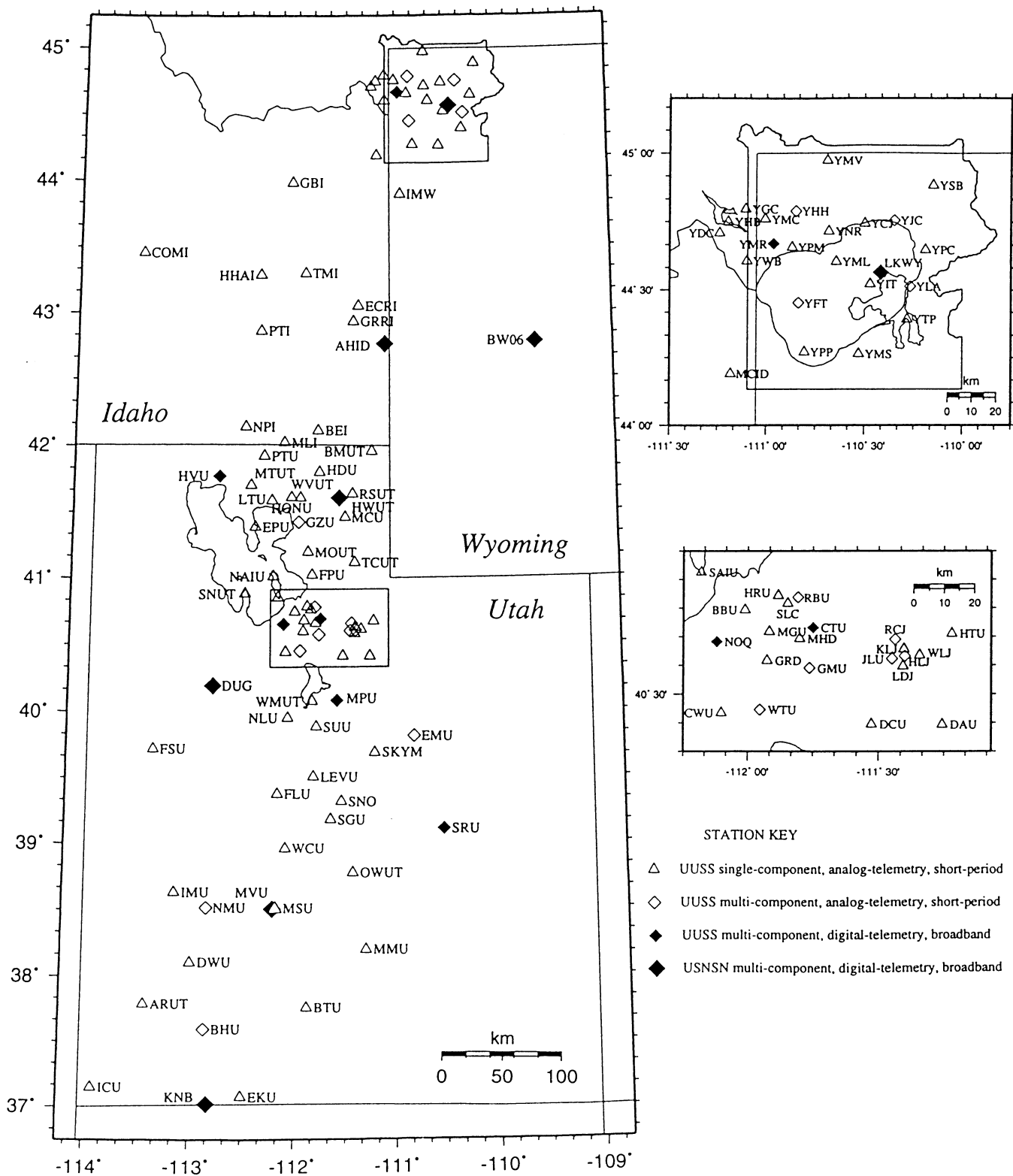


Figure 1



# Utah Regional Earthquakes

January 1 - December 31, 1998

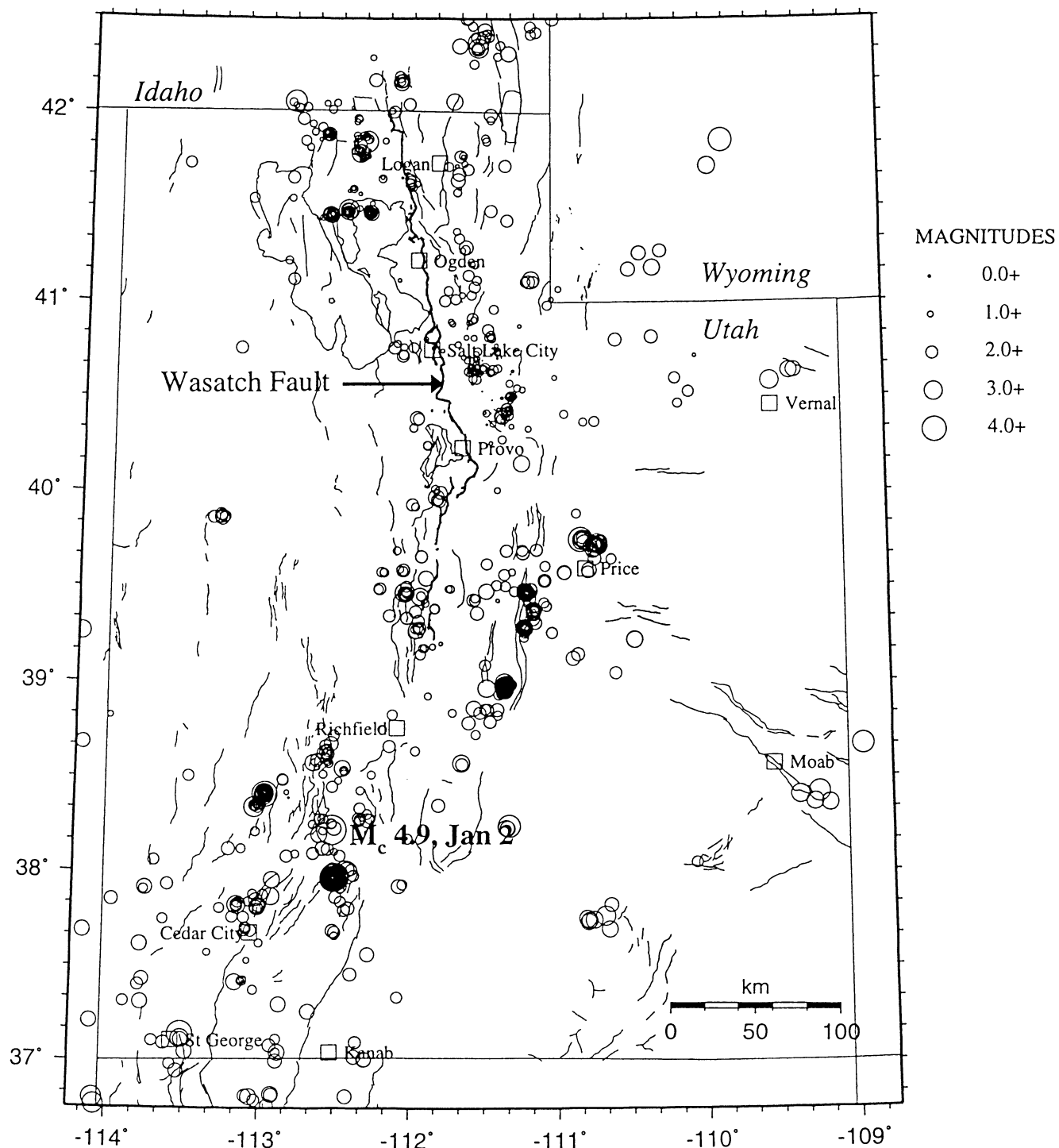


Figure 2

Magnitude 3.0 and Larger Utah Regional Earthquakes  
January 1 - December 31, 1998

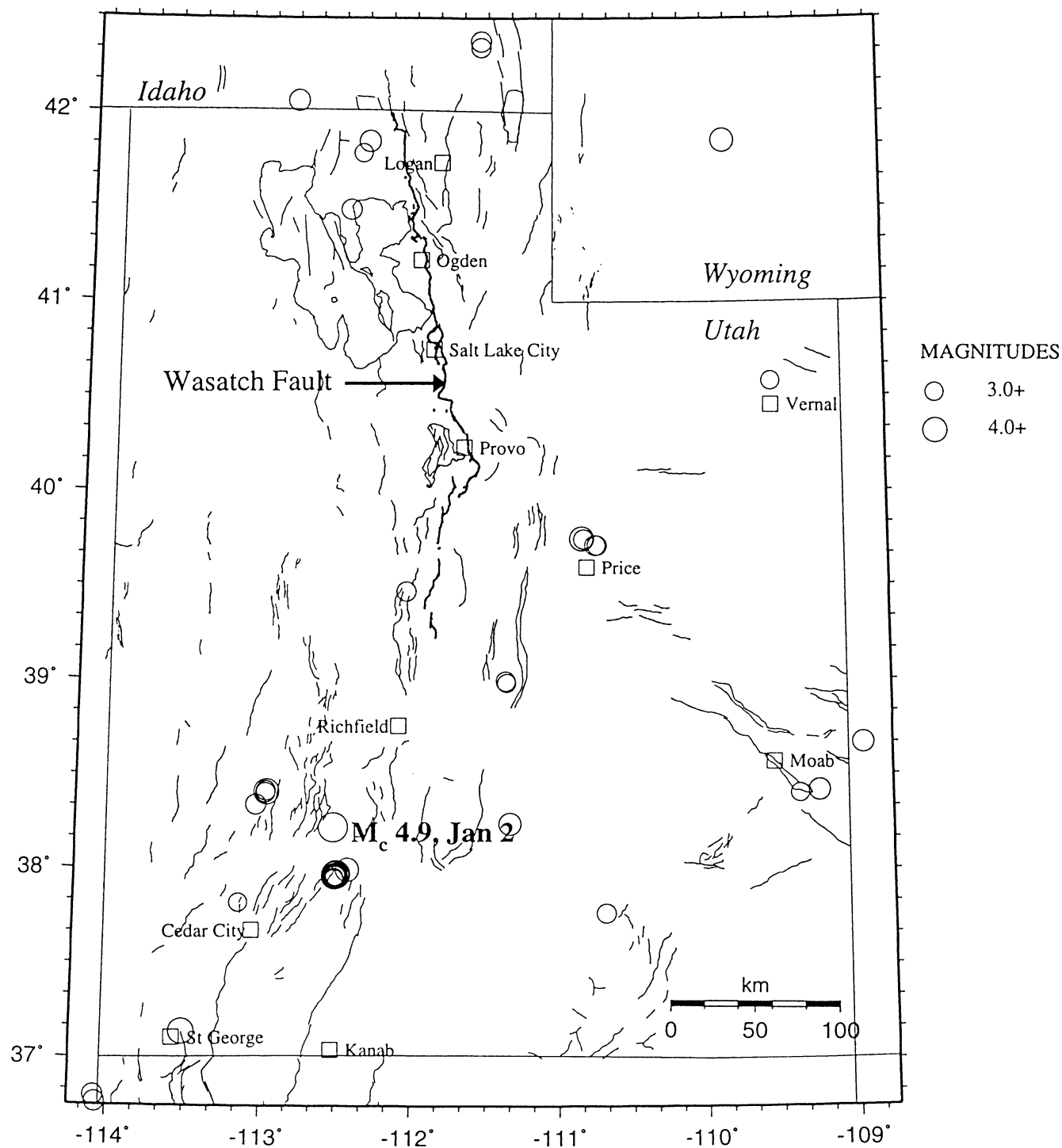


Figure 3

**TABLE 1**  
**UNIVERSITY OF UTAH REGIONAL SEISMIC NETWORK**  
**Operating Seismograph Stations**  
**December 1998**

Code	Location	Latitude(N)	Longitude(W)	Elev(m)	Seism/Elec	Sponsor
+*§ AHID	Auburn, ID	42° 45.92'	111° 06.02'	1957	(USGS)	
ARUT	Antelope Range, UT	37° 47.28'	113° 26.42'	1646	L4/Geotech	Utah
BBUT	Bumble Bee, UT	40° 44.73	112° 00.67'	1291	L4C/U of U	USGS
BEI	Bear River Range, ID	42° 07.00'	111° 46.94'	1859	L4C/U of U	USGS
+ BHU	Blowhard Mtn., UT	37° 35.55'	112° 51.42'	3230	S13/U of U	Utah
BMUT	Black Mtn., UT	41° 57.49'	111° 14.05'	2243	S13/Geotech	USGS
BTU	Barney Top, UT	37° 45.34'	111° 52.46'	3235	S13/U of U	Utah
+*§ BW06	Boulder, WY	42° 46.66'	109° 33.33'	2200	(USGS)	
*§ COMI	Craters of the Moon, ID	43° 27.72'	113° 35.64'	1890	(INEEL)	
+ CTU	Camp Tracy, UT	40° 41.55'	111° 45.02'	1731	40T/REF TEK	USGS
CWU	Camp Williams, UT	40° 26.75'	112° 06.13'	1945	L4C/U of U	USGS
DAU	Daniels Canyon, UT	40° 24.75'	111° 15.35'	2771	S13/U of U	USGS,USBR
DCU	Deer Creek Res., UT	40° 24.82'	111° 31.61'	1829	L4/U of U	USGS,USBR
+++ DUG	Dugway, UT	40° 11.70'	112° 48.80'	1477	S13/U of U	Utah,USGS
+ DUG	Dugway, UT	40° 11.70'	112° 48.80'	1477	(USGS)	
DWU	Dry Willow, UT	38° 06.32'	112° 59.85'	2270	S13/Develco	Utah
*§ ECRI	Eagle Creek, ID	43° 03.20'	111° 22.30'	2086	(INEEL)	
EKU	East Kanab, UT	37° 04.48'	112° 29.81'	1829	S13/U of U	Utah
++ EMU	Emma Park, UT	39° 48.84'	110° 48.92'	2268	S13/U of U	USGS
EPU	East Promontory, UT	41° 23.49'	112° 24.53'	1436	L4C/U of U	USGS
FLU	Fool's Peak, UT	39° 22.69'	112° 10.29'	1951	18300/U of U	USGS
FPU	Francis Peak, UT	41° 01.58'	111° 50.21'	2816	L4C/U of U	USGS
FSU	Fish Springs, UT	39° 43.35'	113° 23.48'	1487	18300/U of U	Utah
*§ GBI	Big Grassy Butte, ID	43° 59.25'	112° 03.80'	1561	(INEEL)	
+ GMU	Granite Mtn., UT	40° 34.53'	111° 45.79'	1829	L4C/U of U	USGS
GRD	Gardner Farm, UT	40° 35.90'	111° 55.55'	1323	Ranger/U of U	USGS
*§ GRR1	Grays Lake, ID	42° 56.28'	111° 25.30'	2207	(INEEL)	
++ GZU	Grizzly Peak, UT	41° 25.53'	111° 58.50'	2646	S13/U of U	USGS
HDU	Hyde Park, UT	41° 48.27'	111° 45.89'	1853	L4C/U of U	USGS
*§ HHAI	Hell's Half Acre, ID	43° 17.70'	112° 22.74'	1371	(INEEL)	
+ HLJ	Hailstone, UT	40° 36.63'	111° 24.04'	1931	S13/U of U	USBR
HONU	Honeyville, UT	41° 36.90'	112° 03.00'	1515	L4C/U of U	USGS
HRU	Hogsback Ridge, UT	40° 47.17'	111° 53.09'	1640	Ranger/U of U	USGS
HTU	Hoyt, UT	40° 40.52'	111° 13.21'	2576	L4C/J302	USGS
++ HVU	Hansel Valley, UT	41° 46.78'	112° 46.50'	1609	40T/REF TEK	USGS
+* HWUT	Hardware Ranch, UT	41° 36.44'	111° 33.90'	1720	(USGS)	
ICU	Indian Springs Canyon, UT	37° 08.98'	113° 55.41'	1451	S13/U of U	Utah
IMU	Iron Mtn., UT	38° 37.99'	113° 09.50'	1833	L4C/Develco	Utah
*§ IMW	Indian Meadows, WY	43° 53.82'	110° 56.35'	2646	(INEEL)	
++ JLU	Jordanelle, UT	40° 36.12'	111° 27.00'	2285	S13/U of U	USBR
KLJ	Keetley, UT	40° 37.85'	111° 24.30'	1992	S13/U of U	USBR
+* KNB	Kanab, UT	37° 01.00'	112° 49.35'	1715	(USGS)	
LDJ	Lady, UT	40° 34.89'	111° 24.47'	2217	S13/U of U	USBR
LEVU	Levan, UT	39° 30.39'	111° 48.88'	1996	L4C/Develco	USGS

Code	Location	Latitude(N)	Longitude(W)	Elev(m)	Seism/Elec	Sponsor
+*§ LKWY	Lake, WY	44° 33.90'	110° 24.00'	2424	(USGS)	
LTU	Little Mtn., UT	41° 35.51'	112° 14.83'	1585	L4C/U of U	USGS
§# MCID	Moose Creek, ID	44° 11.42'	111° 10.96'	2149	L4C/U of U	USGS
MCU	Monte Cristo Peak, UT	41° 27.70'	111° 30.45'	2664	18300/U of U	USGS
MGU	Meadow Brook Golf, UT	40° 40.89'	111° 55.09'	1291	Ranger/U of U	USGS
MHD	Mile High Drive, UT	40° 39.64'	111° 48.05'	1597	Ranger/U of U	USGS
MLI	Malad Range, ID	42° 01.61'	112° 07.53'	1896	L4C/U of U	USGS
MMU	Miners Mtn., UT	38° 11.91'	111° 17.66'	2387	S13/Develco	Utah
MOUT	Mount Ogden, UT	41° 11.94'	111° 52.73'	2743	S13/U of U	USGS
†+ MPU	Maple Canyon, UT	40° 00.93'	111° 38.00'	1909	40T/REF TEK	Utah
MSU	Marysvale, UT	38° 30.74'	112° 10.63'	2105	18300/Geotech	Utah
MTUT	Morton Thiokol, UT	41° 42.55'	112° 27.28'	1373	L4C/U of U	USGS
+* MVU	Marysvale, UT	38° 30.25'	112° 12.74'	2240	(USGS)	
NAIU	N. Antelope Island, UT	41° 00.97'	112° 13.68'	1472	L4C/U of U	USGS
NLU	North Lilly, UT	39° 57.29'	112° 04.50'	2036	S13/U of U	USGS
++ NMU	North Mineral Mt., UT	38° 30.99'	112° 51.00'	1853	S13/U of U	Utah
+ NOQ	N. Oquirrh Mtns., UT	40° 39.15'	112° 07.22'	1622	40T/REF TEK	USGS
NPI	N. Pocatello, ID	42° 08.84'	112° 31.10'	1640	L4C/Develco	USGS
OWUT	Old Woman Plat., UT	38° 46.80'	111° 25.42'	2568	L4C/Geotech	Utah
PTI	Pocatello Valley, ID	42° 52.22'	112° 22.21'	1670	L4C/U of U	USGS
PTU	Portage, UT	41° 55.76'	112° 19.48'	2192	L4C/Geotech	USGS
RBU	Red Butte Canyon, UT	40° 46.85'	111° 48.50'	1676	L4C/U of U	USGS
+ RCJ	Ross Creek, UT	40° 39.51'	111° 26.36'	2090	S13/U of U	USBR
RSUT	Red Spur, UT	41° 38.31'	111° 25.90'	2682	S13/Geotech	USGS
SAIU	S. Antelope Island, UT	40° 51.29'	112° 10.89'	1384	L4C/U of U	USGS
SGU	Sterling, UT	39° 10.94'	111° 38.68'	2357	L4C/U of U	USGS
SKYM	Skyline Mine, UT	39° 41.29'	111° 12.63'	2941	L4/Geotech	Utah
SLC	Salt Lake City, UT	40° 45.97'	111° 50.86'	1436	WA Sim/Hard Wire	USGS
* SNO	Snow College, UT	39° 19.18'	111° 32.33'	2503	Ranger/U of U	SNOW
SNUT	Stanbury North, UT	40° 53.14'	112° 30.54'	1652	18300/U of U	USGS
SRU	San Rafael Swell, UT	39° 06.65'	110° 31.43'	1804	18300/U of U	Utah
†+ SRU	San Rafael Swell, UT	39° 06.65'	110° 31.43'	1804	40T/REF TEK	Utah,LLNL
SUU	Santaquin Canyon, UT	39° 53.29'	111° 47.45'	2024	18300/Develco	USGS
TCUT	Toone Canyon, UT	41° 07.07'	111° 24.51'	2320	L4C/U of U	USGS
*§ TMI	Taylor Mt., ID	43° 18.33'	111° 55.09'	2179	(INEEL)	
WCU	Willow Creek, UT	38° 57.88'	112° 05.44'	2673	18300/U of U	USGS
WLJ	Wildlife, UT	40° 36.80'	111° 20.68'	2075	S13/U of U	USBR
WMUT	West Mountain, UT	40° 04.60'	111° 50.00'	1981	L4C/U of U	USGS
++ WTU	W. Traverse Mtn., UT	40° 27.29'	111° 57.18'	1579	40T/U of U	USGS
WVUT	Wellsville, UT	41° 36.61'	111° 57.55'	1828	L4C/U of U	USGS
§# YCJ	Canyon Junction, YNP, WY	44° 44.63'	110° 29.85'	2426	L4C/U of U	USGS
§# YDC	Denny Creek, MT	44° 42.57'	111° 14.38'	2025	L4C/U of U	USGS
+§# YFT	Old Faithful, YNP, WY	44° 27.08'	110° 50.15'	2292	40T/U of U	USGS
§# YGC	Grayling Creek, MT	44° 47.77'	111° 06.39'	2075	L4C/U of U	USGS
§# YHB	Horse Butte, MT	44° 45.07'	111° 11.71'	2157	L4C/U of U	USGS
+§# YHH	Holmes Hill, YNP, WY	44° 47.30'	110° 51.03'	2717	S13/U of U	USGS
§# YIT	Gravel Pit, YNP, WY	44° 31.29'	110° 28.33'	2457	L4C/U of U	USGS
§# YJC	Joseph's Coat, YNP, WY	44° 45.33'	110° 20.95'	2684	S13/U of U	USGS
+§# YLA	Lake Butte, YNP, WY	44° 30.76'	110° 16.12'	2580	40T/U of U	USGS
§# YMC	Maple Creek, YNP, WY	44° 45.56'	111° 00.37'	2073	L4/U of U	USGS

Code	Location	Latitude(N)	Longitude(W)	Elev(m)	Seism/Elec	Sponsor
§# YML	Mary Lake, YNP, WY	44° 36.32'	110° 38.59'	2653	L4C/U of U	USGS
+§# YMR	Madison River, YNP, WY	44° 40.12'	110° 57.90'	2149	40T/U of U	USGS
§# YMS	Mount Sheridan, YNP, WY	44° 15.84'	110° 31.67'	3106	L4C/U of U	USGS
§# YMV	Mammoth Vault, YNP, WY	44° 58.42'	110° 41.33'	1829	L4C/U of U	USGS
§# YNR	Norris Junction, YNP, WY	44° 42.93'	110° 40.75'	2336	L4C/U of U	USGS
§# YPC	Pelican Cone, YNP, WY	44° 38.88'	110° 11.55'	2932	L4C/U of U	USGS
§# YPM	Purple Mountain, YNP, WY	44° 39.43'	110 52.12'	2582	L4C/U of U	USGS
§# YPP	Pitchstone Plateau, YNP, WY	44° 16.26'	110° 48.27'	2707	L4C/U of U	USGS
§# YSB	Soda Butte, YNP, WY	44° 53.04'	110° 09.06'	2072	L4/U of U	USGS
§# YTP	The Promontory, YNP, WY	44° 23.51'	110° 17.10'	2384	L4C/U of U	USGS
§# YWB	West Boundary, YNP, WY	44° 36.35'	111° 06.05'	2310	L4C/U of U	USGS

**KEY**

J302	—	USGS design	USGS	—	U.S. Geological Survey
L4, L4C	—	Mark Products	Utah	—	State of Utah
S13, 18300	—	(Geotech) S13 or 18300	SNOW	—	Snow College
U of U	—	University of Utah	INEEL	—	Idaho National Engineering and Environmental Lab
WA Sim	—	Wood-Anderson (electronically simulated)	USBR	—	U.S. Bureau of Reclamation
40T	—	Guralp CMG-40T	LLNL	—	Lawrence Livermore National Lab
REF TEK	—	REF TEK field digitizer 72A-07, 24bit, digitally-telemetered			

- # Station part of the Yellowstone Seismograph Network
- \* Indicates station operated by another agency and recorded as part of University of Utah regional seismic network
- § Station located outside of the Utah Region but included in listing for convenient record keeping
- + Indicates 3-component station (one vertical, two horizontals)
- ++ Indicates 4-component station (high- and low-gain verticals plus two horizontals)
- +++ Indicates 6-component station (three high-gain, three low-gain)

TABLE 2  
Earthquakes in the Utah Region: Magnitude 3.0 and Larger, 1998

<i>date</i>	<i>orig time</i>	<i>latitude</i>	<i>longitude</i>	<i>depth</i>	<i>mag</i>	<i>no</i>	<i>gap</i>	<i>dmn</i>	<i>rms</i>
98 102	728 29.40	38° 13.47'	112° 31.19'	4.9*	4.9	15	65	43	0.15
98 130	2153 14.82	37° 58.30'	112° 30.45'	1.3*	4.4	14	66	45	0.35
98 131	803 50.85	37° 58.12'	112° 30.13'	1.3*	3.1	10	67	46	0.14
98 201	209 21.91	37° 58.09'	112° 30.09'	1.4*	4.1	11	67	46	0.23
98 201	853 16.24	37° 58.16'	112° 29.87'	1.1*	3.8	13	67	46	0.23
98 201	2129 4.46	37° 57.90'	112° 30.12'	1.2*	4.1	10	67	46	0.21
98 202	49 5.89	37° 58.37'	112° 30.08'	1.2*	4.4	10	66	46	0.21
98 203	1244 17.06	37° 57.55'	112° 30.10'	4.8*	3.8	8	77	46	0.13
98 204	1935 41.76	37° 57.57'	112° 30.11'	1.2*	3.7	11	68	46	0.31
98 204	2351 35.68	37° 57.49'	112° 30.44'	1.2*	3.7	12	67	46	0.24
98 205	519 56.62	39° 45.06'	110° 50.74'	1.3	4.0	17	139	8	0.23
98 206	1311 15.74	37° 57.07'	112° 30.55'	1.3*	3.0	11	68	46	0.28
98 211	1429 49.16	37° 58.15'	112° 30.33'	1.2*	3.6	16	67	46	0.36
98 211	2115 41.44	39° 28.34'	112° 2.62'	4.3*	3.2	12	82	15	0.22
98 221	2323 18.05	37° 49.43'	113° 9.32'	1.2*	3.0	9	118	25	0.16
98 316	527 34.24	37° 57.80'	112° 30.47'	4.8*	4.2	9	66	46	0.19
98 318	1013 2.93	37° 57.46'	112° 30.68'	7.0*	3.0	9	67	46	0.14
98 329	1212 42.95	38° 14.58'	111° 19.99'	1.4	3.6	18	110	6	0.42
98 405	2014 55.40	37° 57.96'	112° 30.02'	1.2*	3.8	13	67	46	0.19
98 409	2139 34.38	38° 24.96'	112° 58.71'	3.0*	3.2	13	117	16	0.32
98 410	4 30.03	38° 24.45'	112° 58.94'	1.0*	3.2	15	118	17	0.36
98 410	2007 16.23	38° 24.63'	112° 58.55'	0.3*	4.1	12	117	16	0.36
98 419	451 27.53	37° 57.78'	112° 30.63'	1.6*	3.8	18	67	46	0.38
98 420	2047 28.31	37° 58.07'	112° 29.93'	1.5*	3.3	14	67	46	0.33
98 424	505 49.54	41° 51.04'	112° 19.94'	7.9	3.5	18	77	9	0.14
98 427	336 32.56	41° 29.31'	112° 27.23'	1.8*	3.3	27	137	11	0.22
98 504	1200 12.29	38° 59.80'	111° 21.92'	1.1*	3.2	19	96	25	0.18
98 508	1945 2.98	38° 25.16'	109° 14.67'	3.9*	3.4	9	290	135	0.46
98 509	36 25.11	38° 59.25'	111° 21.53'	0.7*	3.0	14	97	24	0.18
98 514	1226 24.59	42° 22.61'	111° 33.27'	0.3*	3.3	21	166	54	0.31
98 522	208 16.64	37° 59.98'	112° 25.27'	1.2*	3.8	16	84	55	0.45
98 618	1100 40.16	37° 58.45'	112° 29.69'	1.1*	4.7	13	66	46	0.24
98 618	1754 8.46	37° 58.09'	112° 29.85'	1.1*	3.1	14	67	46	0.29
98 716	1311 34.61	37° 8.42'	113° 30.64'	0.4*	4.1	10	177	37	0.45
98 724	914 42.29	42° 3.66'	112° 50.58'	5.8*	3.5	17	260	29	0.23
98 816	214 39.55	42° 20.62'	111° 33.27'	1.5*	3.2	29	110	32	0.23
98 831	41 5.80	37° 46.21'	110° 41.10'	1.5*	3.2	5	247	72	0.34
98 925	539 58.58	38° 40.02'	108° 56.63'	4.7*	3.6	5	261	43	0.15
98 926	1701 59.83	39° 43.00'	110° 45.35'	2.9*	3.3	15	184	12	0.18
981008	1719 11.80	38° 20.58'	113° 2.84'	1.3*	3.3	16	133	27	0.32
981022	2118 7.19	41° 51.30'	109° 50.86'	6.9*	3.8	8	225	105	0.25
981028	2029 31.14	41° 47.34'	112° 22.75'	1.0*	3.1	32	76	11	0.25
981108	416 39.53	39° 44.91'	110° 50.24'	1.5	3.2	14	145	8	0.24
981117	6 27.41	36° 48.01'	114° 4.77'	1.5*	3.4	5	302	41	0.08
981125	701 8.78	40° 34.90'	109° 31.94'	4.0*	3.0	10	235	138	0.30

981207	2032	45.36	36° 45.97'	114° 3.96'	2.1*	3.3	6	301	45	0.35
981215	1144	42.74	38° 24.19'	109° 22.46'	2.8*	3.0	6	290	127	0.74
981216	1918	50.13	39° 43.03'	110° 44.62'	2.3*	3.1	13	193	12	0.23

number of earthquakes = 48  
 \* indicates poor depth control

FELT EARTHQUAKES IN THE UTAH REGION  
January 1, 1998 to December 31, 1998

Date	Time†	Felt Information‡	Latitude	Longitude	Magnitude
Jan 2	07:28 12:08 a.m. MST	Beaver, Circleville, Henrieville, Panguitch, Marysvale, Richfield, (UUSS), Elk Meadows Ski Resort, UT (NEIC)	38° 13.47'	112° 31.19'	M <sub>C</sub> 4.9 UUSS
Jan 3	00:43	Malad City, ID	42° 10.51'	112° 16.72'	M <sub>C</sub> 2.2 UUSS
Jan 2	5:43 p.m. MST	(UUSS)			
Jan 30	21:53 2:53 p.m. MST	Panguitch, UT (UUSS)	37° 58.30'	112° 30.45'	M <sub>C</sub> 4.4 UUSS
Feb 5	05:19	Price, Helper, Martin,	39° 45.06'	110° 50.74'	M <sub>C</sub> 4.0 UUSS
Feb 4	10:19 p.m. MST	Willow Creek Mine, UT (UUSS)			
Mar 16	05:27	Panguitch, Kanarraville, UT	37° 57.80'	112° 30.47'	M <sub>C</sub> 4.2 UUSS
Mar 15	10:27 p.m. MST	(UUSS)			
Mar 29	12:12 5:12 a.m. MST	Capitol Reef, UT (NEIC)	38° 14.58'	111° 19.99'	M <sub>C</sub> 3.6 UUSS
Apr 9	21:39 3:39 p.m. MDT	Milford, UT (NEIC)	38° 24.96'	112° 58.71'	M <sub>C</sub> 3.2 UUSS
Apr 9	21:40 3:40 p.m. MDT	Milford, UT (NEIC)	38° 25.04'	112° 58.38'	M <sub>C</sub> 2.6 UUSS
Apr 10	20:07 2:07 p.m. MDT	Milford, UT (NEIC)	38° 24.63'	112° 58.55'	M <sub>C</sub> 4.1 UUSS
Apr 24	05:05	Garland, Tremonton,	41° 51.04'	112° 19.94'	M <sub>C</sub> 3.5 UUSS
Apr 23	11:05 p.m. MDT	Fielding, Portage, UT (UUSS)			
Jun 18	11:00 5:00 a.m. MDT	Panguitch, UT (UUSS)	37° 58.45'	112° 29.69'	M <sub>C</sub> 4.7 UUSS
Jul 16	13:11 7:11 a.m. MDT	Santa Clara, St. George, Washington, UT (NEIC)	37° 08.42'	113° 30.64'	M <sub>C</sub> 4.1 UUSS
Nov 23	23:48 4:48 p.m. MST	Willow Creek Mine, UT (UUSS)	39° 45.48'	110° 50.16'	M <sub>C</sub> 2.8 UUSS
Dec 13	02:04	Payson, UT (UUSS)	39° 58.32'	111° 49.83'	M <sub>C</sub> 2.8 UUSS
Dec 12	7:04 p.m. MST				

Notes:  
† Date and Time listed first as local date and time (either Mountain Standard or Mountain Daylight Time), then as UTC (Universal Coordinated Time) in brackets. UTC is Mountain Standard Time plus 7 hours (MDT + 6 hours). The local date is only listed if different from the UTC date.  
‡ Felt information from UUSS and/or from the U.S. Geological Survey serial publication *Preliminary Determination of Epicenters - Monthly Listings, 1998*. Roman numerals correspond to the modified Mercalli intensity scale and were assigned by the U.S. Geological Survey.



## ACCOMPLISHMENTS

### Routine Network Operations

During the 1998 award period summarized in this report, all responsibilities for network operations and earthquake data processing were fulfilled. The required Annual Project Summaries of specific activities and results was submitted to the USGS in November 1998. Four quarterly epicenter bulletins for the Utah region were published.

### Internet Access to Utah Earthquake Information

During the project period, we made significant progress towards a substantial upgrade of our Web pages, which will soon include (1) a complete reorganization of pages to make them more user friendly, (2) implementation of the USGS seismicity map presentation format, and (3) the presentation of seismic data to GIS users in Arc/Info native format.

### Analog Network and Central Recording Lab Upgrades

We have continued a systematic upgrading of the field electronics throughout our aging analog telemetry network. The field upgrade includes: (1) reconditioning of all L4 seismometers, including the addition of a calibration coil to enable *in situ* determination of the system response of every station (20 out of 22 L4 seismometers have now been reconditioned); (2) installation of temperature-compensated solar regulators to prevent a non-recoverable battery discharge when an adequate source of solar power is unavailable; (3) installation of RF cavity filters to reduce radio interference at microwave relay sites; (4) replacement of aging seismometer and battery barrels; (5) installation of grounding and improved lightning protection; (6) installation of bandpass filters and audio multiplexers at intermediate relay points; (7) addition of insulation to extend field life of station batteries; (8) tuning/upgrading VCO's; and (9) determination of GPS-quality station locations using Univ. of Utah Trimble SSI dual-frequency receivers.

### Rapid Earthquake Alert

We substantially completed our efforts to integrate new digital data streams (REF TEK and USNSN) with our existing analog data streams for routine analysis. We completed a detailed analysis of Rex Allen's picker algorithm, as implemented within Earthworm, and preliminary "tuning" of Earthworm's picker to perform reliably on Utah waveform data (see Pechmann, 1998). We prepared for testing of the Antelope real-time data acquisition system cooperatively developed by Kinematics and Boulder Real-time Technologies.

### New Digitally-telemetered Broadband Stations

We completed installation of two new broadband, digitally-telemetered seismograph stations in the Wasatch Front area in Utah. One station is located in the seismically active area north of the Great Salt Lake in Hansel Valley. The other station is located along the southeastern edge of Utah Valley in north-central Utah. Both of the new stations are located on bedrock. The Hansel Valley instrumentation is housed in a previously constructed seismic vault. During preceding report periods, we completed installation of two similar stations installed on bedrock sites located on the east and west sides of the Salt Lake Valley. Each of the four station consists of a Guralp CMG40T broadband seismometer, a REF TEK 24-bit digitizer, and a digital telemetry link to our central recording lab. Three of the sites are solar-powered; the fourth site has AC-power available. Three of these stations require intermediate radio relays. A third new broadband, digitally-telemetered seismograph station was installed in 1998 in east-central Utah with other funds. Data from these stations are acquired with the aid of Dataserver software developed by the University of Nevada, Reno. These data are integrated into the *Earthworm* data stream for rapid alert purposes using UUSS-developed software. The installation of these three new stations brings the total number of broadband stations within or immediately bordering the Utah region to eleven (5 University of Utah, plus 6 USNSN). During the

report period, we completed a compilation of the response data for the Utah broadband stations and have submitted this information to the USNSN.

#### **Routine Use of Broadband Data for Local Magnitude Calculations**

During the report period, we systematically determined local magnitudes ( $M_L$ ) and computed  $M_L$  station corrections using local USNSN and Utah broadband stations, for all coda magnitude ( $M_C$ ) 2.5 and greater earthquakes located in the Utah region since January 1, 1994. The project involved the analysis of more than 1500 earthquakes in the Intermountain Seismic Belt, including 271 events of a major aftershock sequence. The final stage of the project is incomplete due to difficulties we encountered obtaining exact calibration data from the USNSN for station DUG. We recently obtained the required calibration information and expect the magnitude project will be completed in early 1999.

#### **Contributions to the CNSS Composite Catalog and Network Inventory**

During the report period, we continued submission of the Utah region earthquake catalog to the Council of the National Seismic System's composite earthquake database. During 1998, we began automated data submission several times per day to the CNSS catalog. We completed a network station inventory for the CNSS (see <http://www.cnss.org/NETS>) and major progress towards a comprehensive station inventory for the IASPEI handbook.

#### **Long-term Archiving of Seismic Waveform Data**

Preparations continued for submitting 17 years of Univ. of Utah analog-telemetry waveform data (1981-present) to the IRIS Data Management Center in SEED format. The preparations include: (1) installation and use of the PDCC (Portable Data Collection Center) software for tracking the required data, (2) continued compilation of a database inventory of instrument components for all stations in our network since digital recording began in 1981, and (3) preliminary determination of the system response for all stations in our network. We also began work on software to automatically convert Utah digitally-telemetered, broadband data to SEED format.

#### **Year 2000 Vulnerability Analysis**

During the report period, we completed an extensive assessment of our network-related computer systems and equipment for Year 2000 (Y2K) vulnerability. This information was submitted to the USGS at their request during the report period. We purchased a Y2K compliant operating system for our primary data acquisition system. Installation and testing of Y2K compliant software will occur during 1999.

### **AVAILABILITY OF DATA**

All seismic waveform data archived by the University of Utah Seismograph Stations are available upon request (typically delivered to the user in SAC ASCII or binary format). Earthquake catalog data for the Utah region are available via anonymous ftp <[ftp.seis.utah.edu: pub/UUSS\\_catalogs](ftp://ftp.seis.utah.edu/pub/UUSS_catalogs)>, or by e-mail request to [request-quake@eqinfo.seis.utah.edu](mailto:request-quake@eqinfo.seis.utah.edu), or via the Council of the National Seismic System's composite earthquake catalog, <<http://quake.geo.berkeley.edu/cnss>>. See also the University of Utah Seismograph Stations homepage on the World-Wide Web <<http://www.seis.utah.edu>>. The contact person for data requests is Susan J. Nava, Network Manager, tel: (801) 581-6274; e-mail: [nava@seis.utah.edu](mailto:nava@seis.utah.edu).

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Pechmann, J.C. (1998). Suggested picker parameter changes (published on homepage of the Council of the National Seismic System; see [http://www.cnss.org/EWAB/ovr/picker\\_tune.html](http://www.cnss.org/EWAB/ovr/picker_tune.html))

Pechmann, J.C., D.A. Brumbaugh, S.J. Nava, T.G. Skelton, G.P. Fivas, W.J. Arabasz, S.M. Jackson (1997). The 1994 Draney Peak, ID, earthquake and its aftershocks (abstract), *EOS, Trans. Am. Geophys. Union* **78**, no. 46 (Supplement), F480.

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